Applications of RIA to ATW

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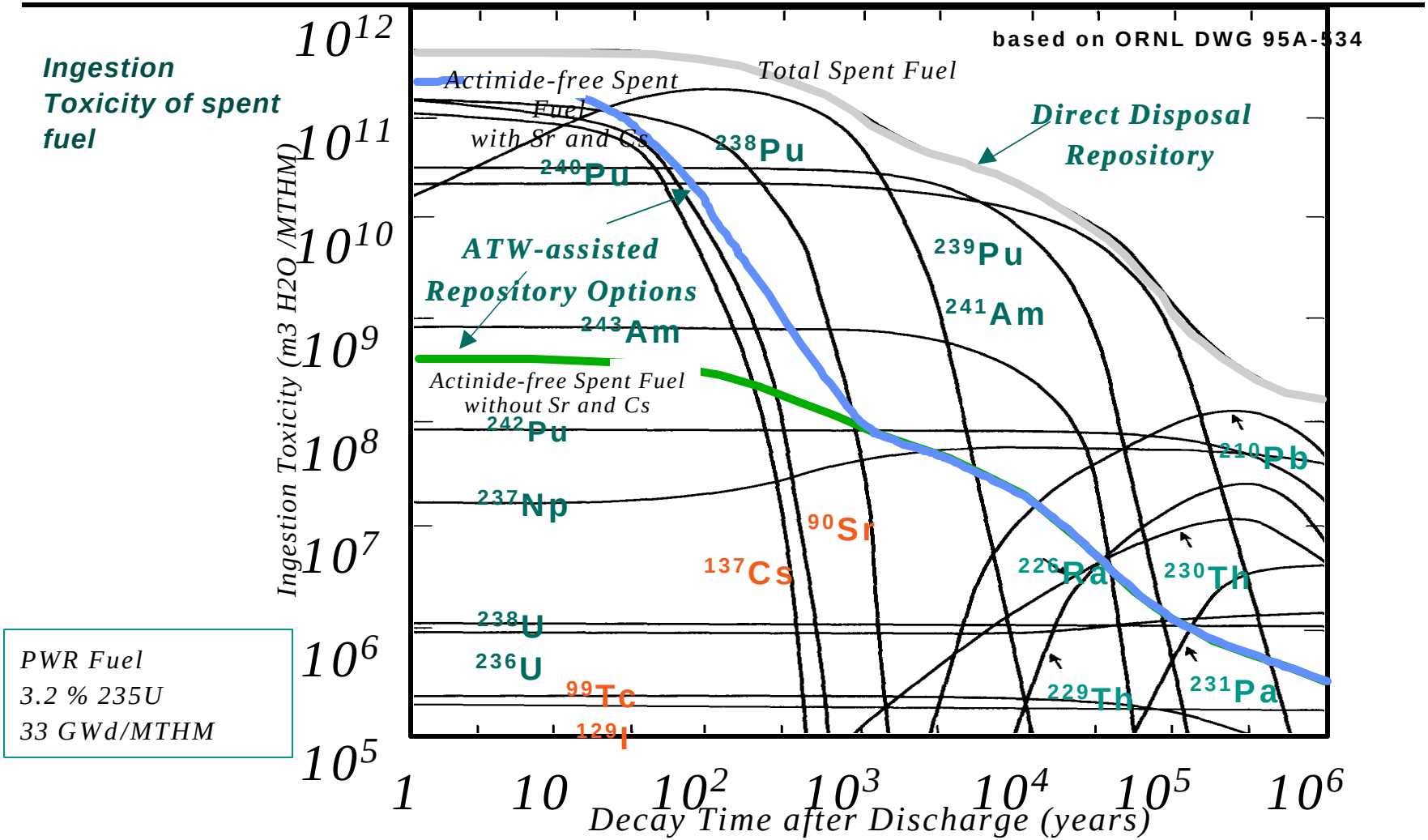
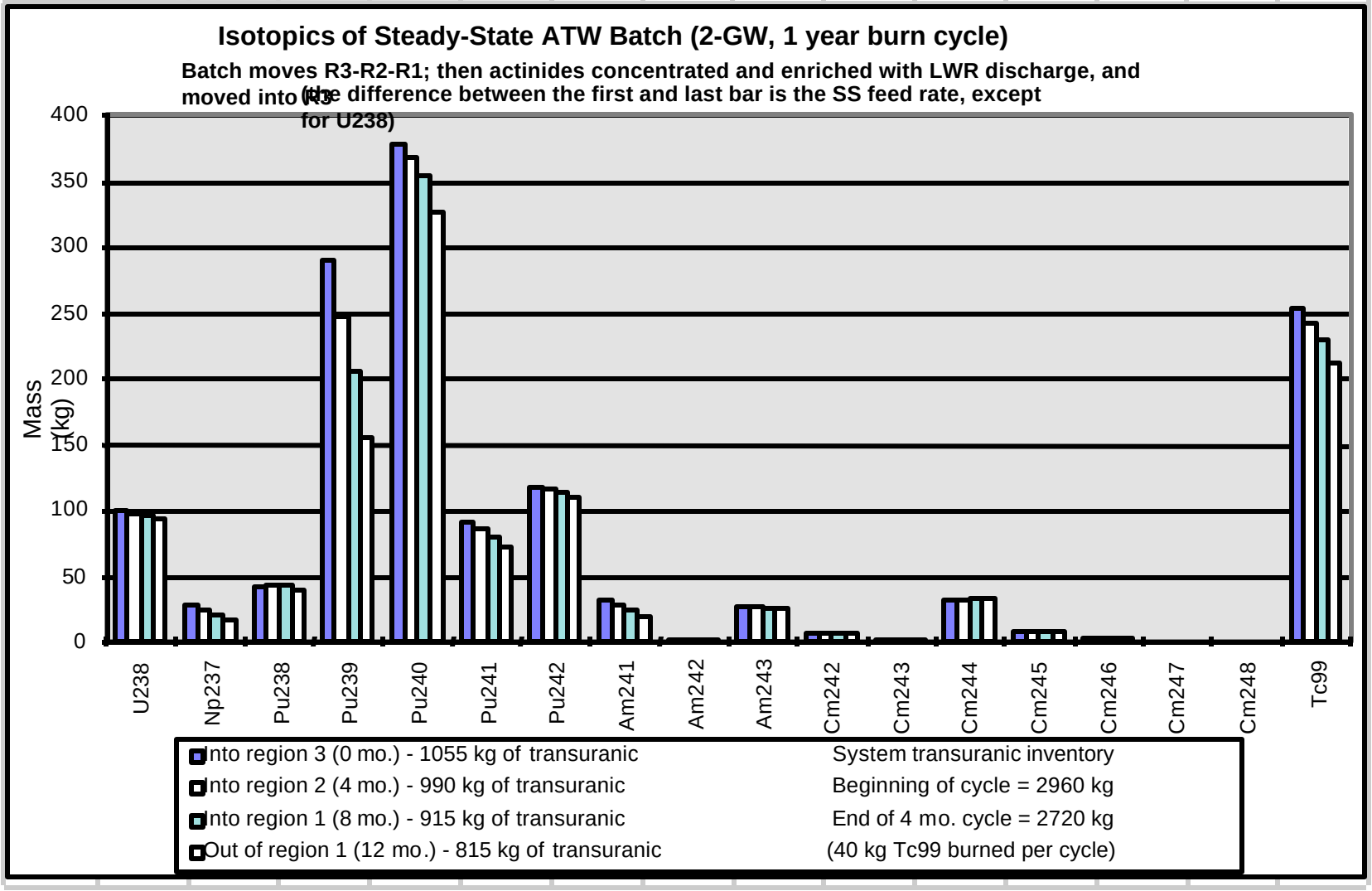
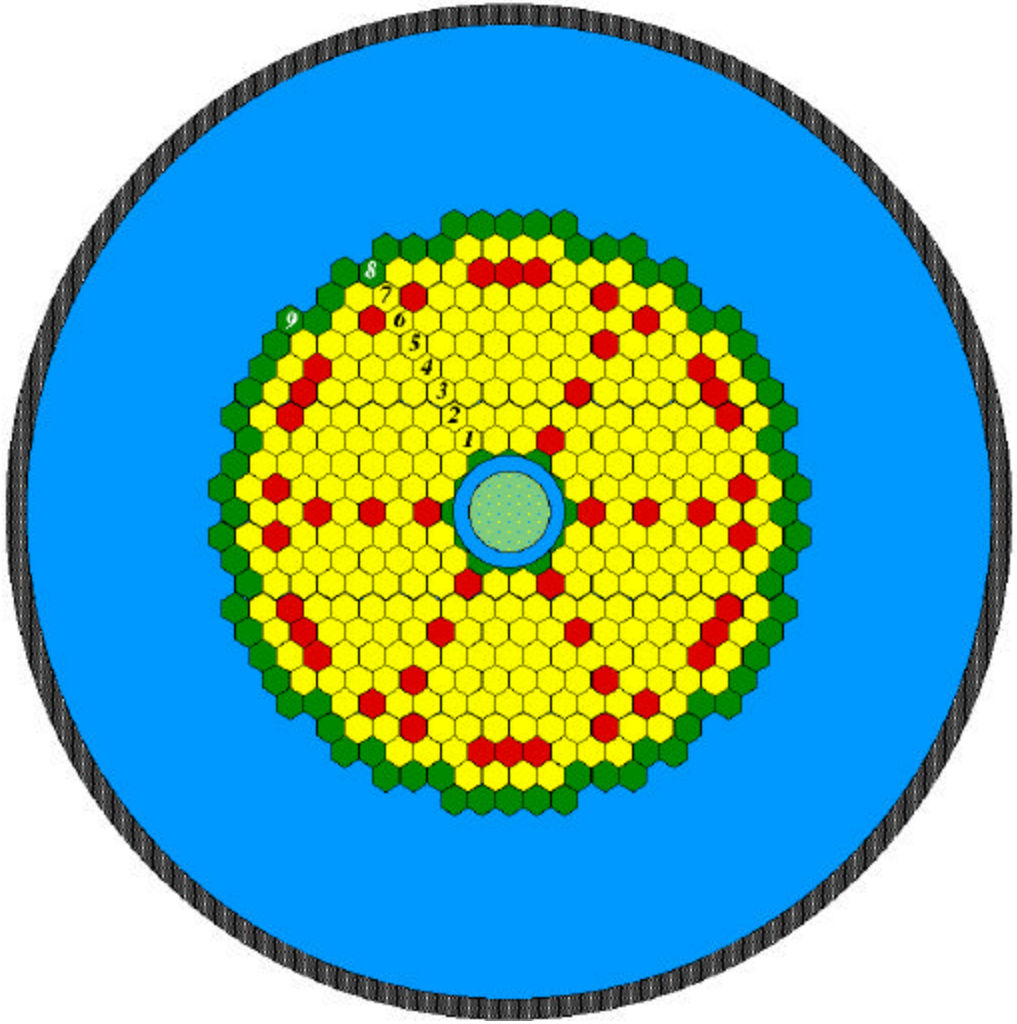
The objective of ATW is to eliminate the long-lived actinides



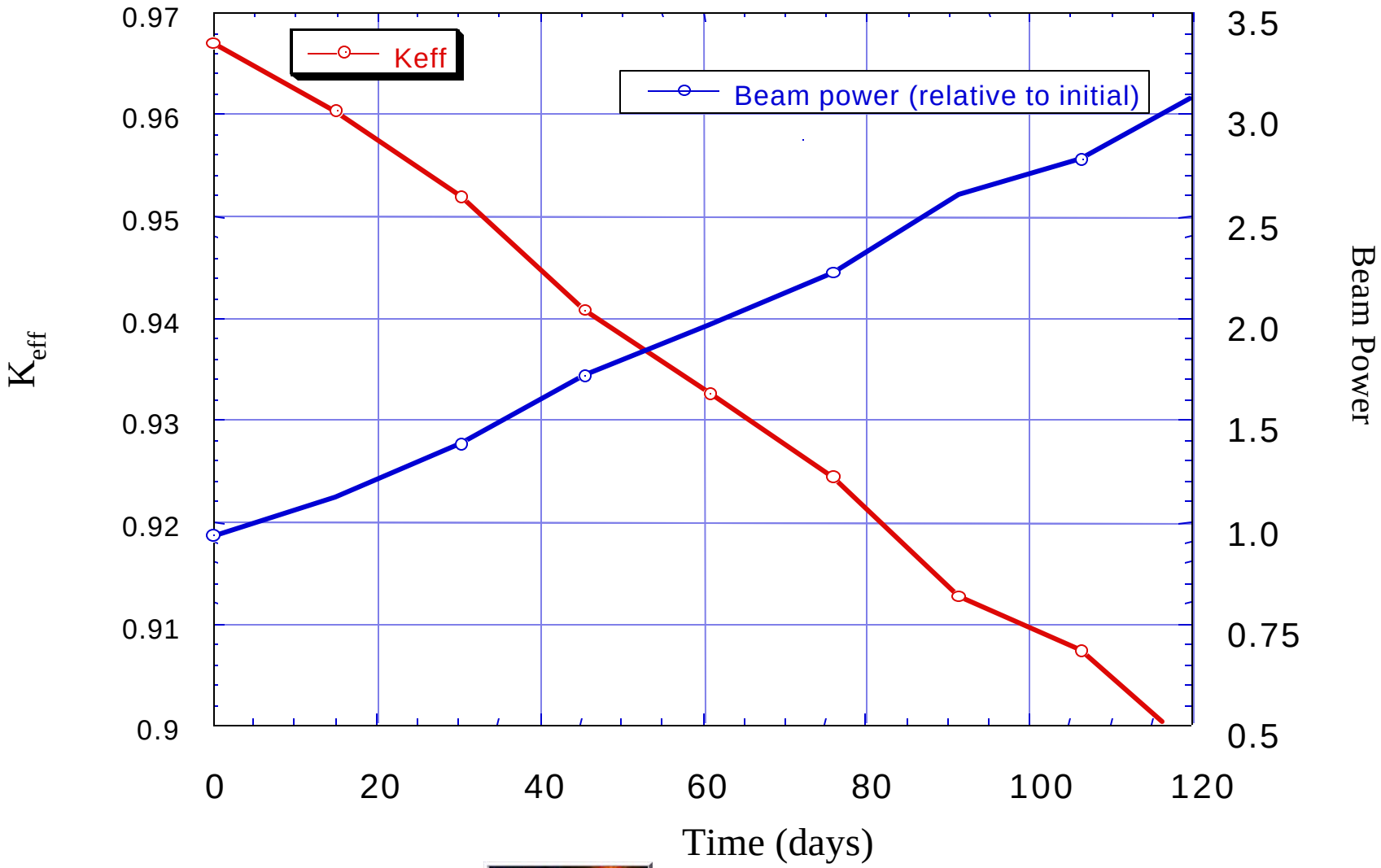
Design scenarios have complicated mix of actinides in fuel



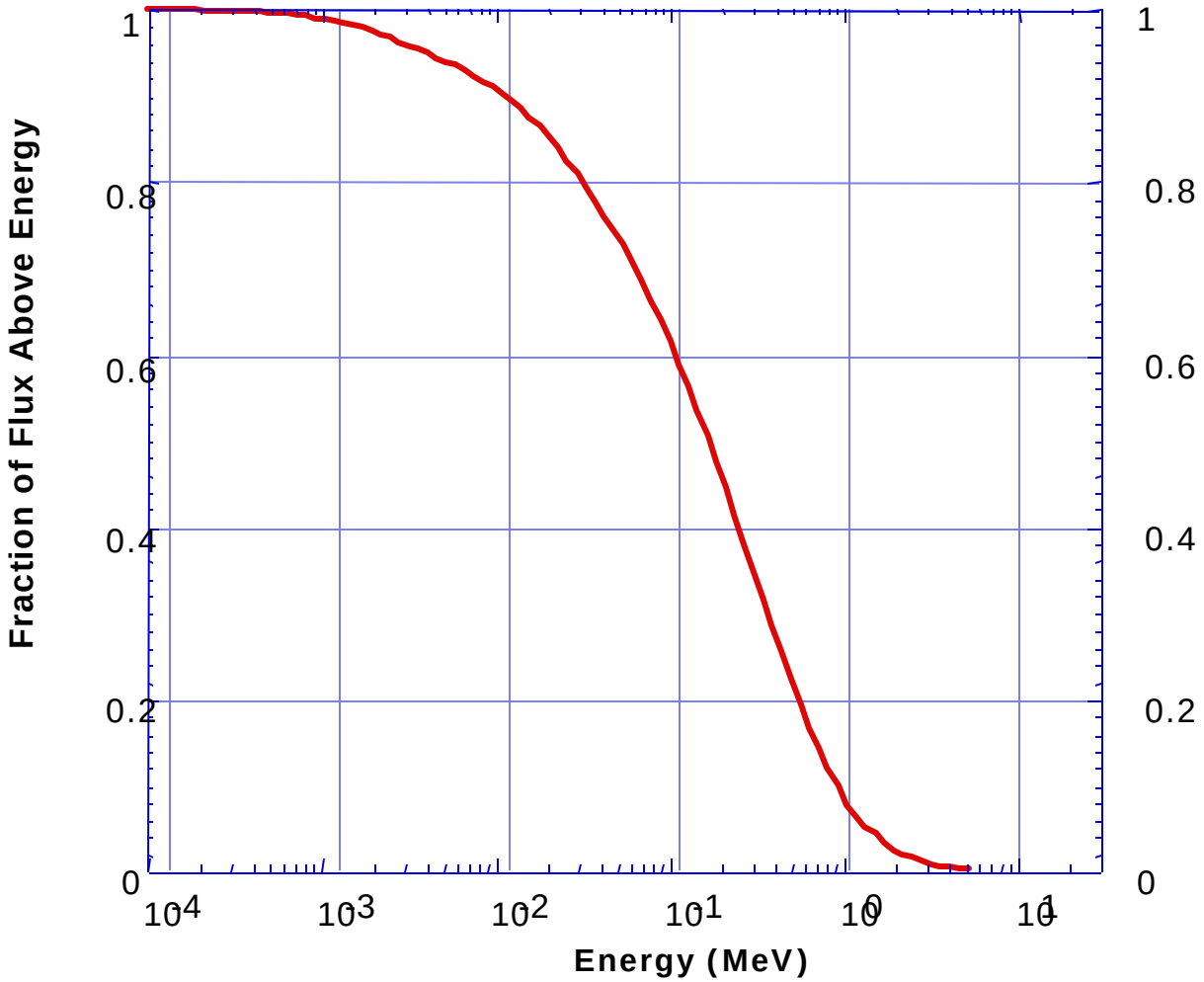
Irradiated fuel elements would be assembled around the spallation source and cooled by Pb-Bi coolant



Reactivity decreases as Pu is burned



Neutron flux is fast compared to a reactor spectrum



A joint LANL/LLNL proposal was developed for measurement of nuclear data needed by ATW

- Code sensitivity studies
- Update ENDF for minor transuranics, bismuth, fission products
- New ENDF libraries to 150 MeV
- Fission cross sections for transuranics to E_n = 200 MeV
- Capture cross sections in transuranics and bismuth
- Capture cross sections for ^{99}Tc, ^{135}Cs and other long-lived fission prod.
- Total cross section for ^{99}Tc
- Spallation product yield in Bi and Pb
- Z and A distribution of fission products
- Fission neutron multiplicity measurements in transuranics

There is a cost driver for these measurements

$$f = \frac{S}{1 - K_{eff}}$$

- **Accelerator power costs about 10 M$/MW**
  - *In the case of APT the target yield initially had uncertainty ~ 20%*
  - *Accelerator cost was ~ 2 G$*
  - *Engineering design margin of 20% added 400M$ to the accelerator cost*
  - *Reducing the target production uncertainty to 10% saved 200M$*
- **ATW has similar arithmetic**
  - *If uncertainty in K_{eff} forces it below 0.9 then there is a large accelerator cost associated with that uncertainty*

Measured cross sections with good accuracy are cost effective

Fission cross sections for transuranics

- **Some transuranic fission cross sections are poorly known at all energies**
- **Most transuranic fission cross sections are poorly known above E_n=20 MeV**
  - *Would like measurements to E_n=200 MeV*
    - High precision (< 5 %) required below about 5 MeV
  - *This determines power distribution and is critical parameter*
- **K_{eff} is an important safety parameter and must be accurately predicted**
  - *Neutron spectrum is very fast*
  - *2-3 % cross section for fission spectrum neutrons is a requirement*
  - *Fission spectrum extends to about 15 MeV*
- **Pu, Am, Cm and possibly Np play important roles in K_{eff}**

Neutron capture cross sections for transuranics, Bi, and fission products

- **^{99}Tc and ^{135}Cs capture is critical to successful transmutation**
  - *Burnup rate is tied to these cross sections*
  - *Targets are radioactive, I.e. good RIA application*
- **Precision data needed to about E_n=500 keV**
- **Capture cross sections in transuranics and Bi are important**
  - *^{209}Bi(n,g)^{210}Bi*
  - *^{210}Bi goes to ^{210}Po*
  - *^{210}Po is a major problem in disposal of waste stream*

Fission product yields in transuranics

- **Fission product yields poorly known across transuranics**
  - *Measured yields would improve the models*
  - *In the end models will be the primary tool, not data*
  - *Fission product yields are important in predicting the waste stream and may be important in safety/transient analysis*
    - I.e. some fission products are important poisons
    - Common experiments measure cumulative yield but RIA can measure the independent yield
    - And, yes, they are radioactive
- **Need to know Z and A distributions**
- **Need to know yield at high neutron energy (fast spectrum)**

Neutron multiplicity

- **K_{eff} depends strongly on neutron multiplicity**
  - *K_{eff} must be known to " 1 %*
  - *Uncertainty in K_{eff} driven by uncertainty in multiplicity*
- **Multiplicity depends on neutron spectrum**
  - *Poorly known for fast neutron spectrum*
  - *Must be measured to ~ 1 % up to 50 MeV*
- **Neutron multiplicity poorly know for transuranics**

RIA is the proper venue to address a subset of the measurements described earlier

- **Waste stream will be dominated by fission products**
  - *We will rely on models to predict the fission product yields*
  - *The models are not good today for the fast neutron spectrum*
  - *RIA measurements can improve the models*
- **Measured fission product yields usually determine only cumulative yield**
  - *RIA allows direct measurements of independent yield*
- **Fission isomers may be important**
  - *Transient analysis must include all important isomers*
  - *RIA allows direct access to isomers*
- **Fission product neutron cross sections are poorly or unknown**
  - *RIA allows direct access to important fission products*
  - *Neutron source at the RIA target facilitates their neutron cross sections*
  - *This may be particularly important for transient analysis in ATW target*

RIA with a neutron source can make cost effective ATW data measurements

- **An ATW accelerator will be expensive**
  - *Engineering design margin driven by data uncertainties can add 100 M$*
  - *The data uncertainty can be reduced by RIA measurements*
- **Fission product yield data can improve models used to predict**
  - *ATW K_{eff}*
  - *and the waste stream*
- **Neutron measurements on radioactive fission products and isomers will improve estimates of K_{eff}**
- **Neutron capture measurements on radioactive components of ATW assemblies (^{99}Tc, ^{135}Cs, etc) are important for estimating burn rate and predicting ultimate composition of ATW waste stream**